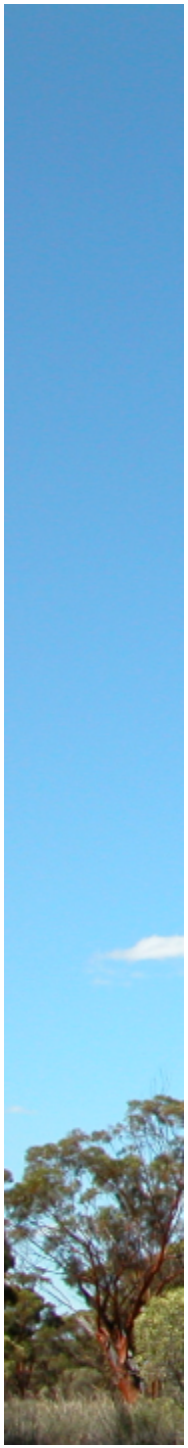
Joint Research Plans - Australia

Beth Ebert and Peter May

Centre for Australian Weather and Climate Research (CAWCR)

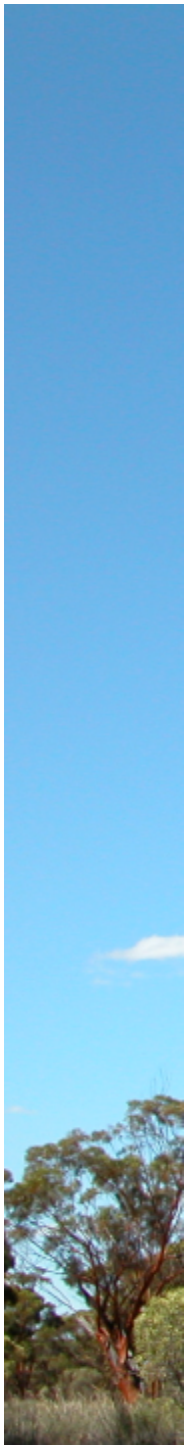
A partnership between the Bureau of Meteorology and CSIRO

GPM GV3, Buzios, Brazil, 4-6 March 2008



Overview

1. National network applications
   - National-scale validation of operational and experimental satellite daily precipitation estimates (IPWG)
   - Validation Network comparison of instantaneous satellite-based and ground-based radar rain rates
2. Physical validation
   - Comparison of cloud and rain properties in satellite and surface radar data
3. Integrated hydrological validation
   - (early planning stages)



IPWG validation of satellite-based rainfall

Objectives and goals:

Pre-launch algorithm development:

- Diagnostic verification leading to improved algorithms
  - Regime-dependent error characteristics
- What blending strategies are most effective for combining data from multiple sensors?
- Can information from non-satellite sources (e.g. models, surface and upper-air observations, etc.) enhance the skill of satellite precipitation algorithms?

Post-launch evaluation:

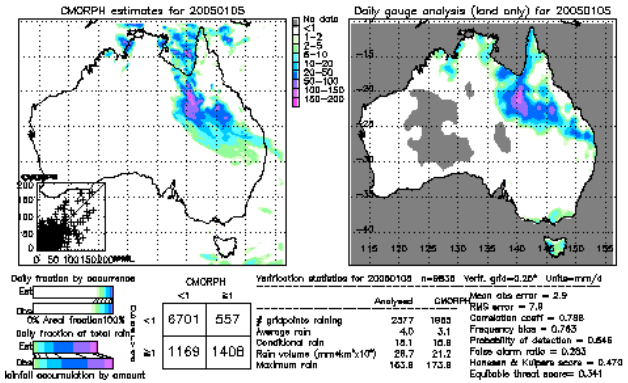
- Ongoing monitoring of satellite precipitation accuracy
- Comprehensive error characterization
- Communication of quality information to users of precipitation data

IPWG validation of satellite-based daily rainfall

Collaborating investigators:

Data providers:

- NASA Goddard Space Flight Center
- NOAA Climate Prediction Center
- NOAA Center for Satellite Applications and Research
- Naval Research Laboratory
- University of California Irvine
- University of Birmingham
- Japan Aerospace Exploration Agency
- European Centre for Medium Range Forecasts
- National Centers for Environmental Prediction



Validation:

- Australian Bureau of Meteorology
- NOAA Climate Prediction Center
- University of Birmingham
- University of Maryland
- Osaka University
- South African Weather Service

Possible future validation partners:

- India Meteorological Department
- Korea Meteorological Administration
- NCAR (West Africa)
- Intl Centre for Integrated Mountain Dev't, Nepal
- Others?

IPWG validation of satellite-based rainfall

Methodology and work plan:

- Nightly FTP of satellite precipitation estimates, verification against operational daily gauge analysis, results posted to web
- Satellite estimates archived at CICS

Daily validation results for daily precipitation estimates, including semi-operational algori
resolution varies by product.

Click here to go to the CPC validation page for the US.
Click here to go to the U. Birmingham validation page for Europe.

Valid Date (00-24 UTC)	Rain Maps	GSFC Combined Microwave	GSFC Calibrated IR	GSFC MPA	NRL Blended IR+Mwave	NRL Merged Mwave	NESDIS AMSU	UCI PERSIANN	CPC Morphed	CPC GDAS Morphed	CPC Morphed +IR	CPC Merged Mwave
20080225	all	3B40RT	3B41RT	3B42RT	geo	pmw	---	---	---	---	---	---
20080224	all	3B40RT	3B41RT	3B42RT	geo	pmw	AMSU	PERSIANN	CMORPH	GMORPH	CMPHIR	MWCOMB
20080223	all	3B40RT	3B41RT	3B42RT	geo	pmw	AMSU	PERSIANN	CMORPH	GMORPH	CMPHIR	MWCOMB
20080222	all	3B40RT	3B41RT	3B42RT	geo	pmw	AMSU	PERSIANN	CMORPH	GMORPH	CMPHIR	MWCOMB
20080221	all	3B40RT	3B41RT	3B42RT	geo	pmw	AMSU	PERSIANN	CMORPH	GMORPH	CMPHIR	MWCOMB
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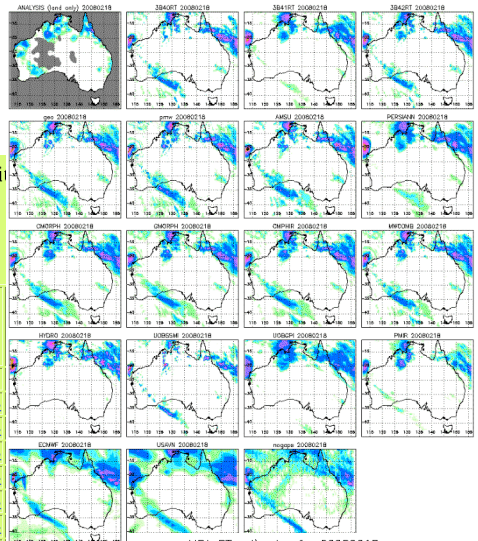
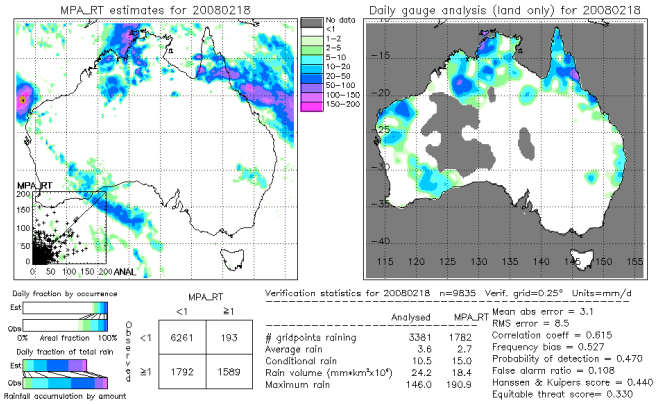


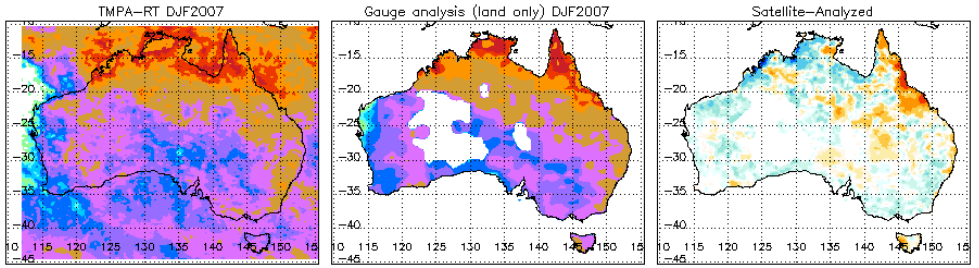


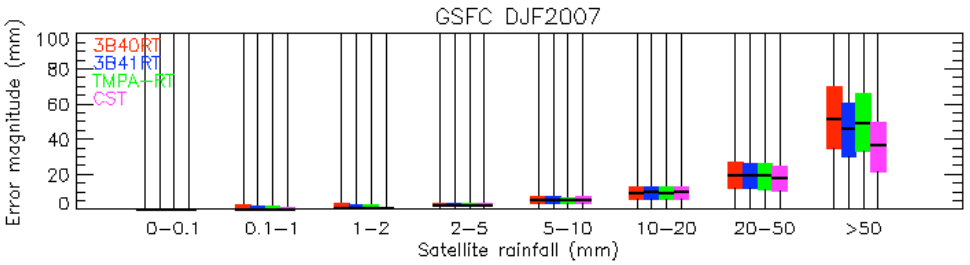
IPWG validation of satellite-based rainfall

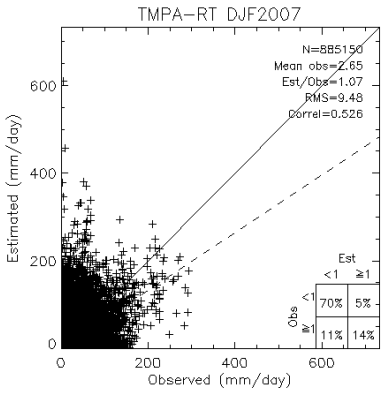
- Monthly and seasonal diagnostic validation summaries

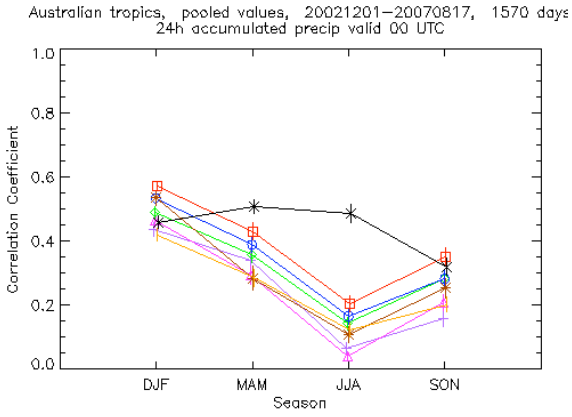
Comparative statistics for DJF2007

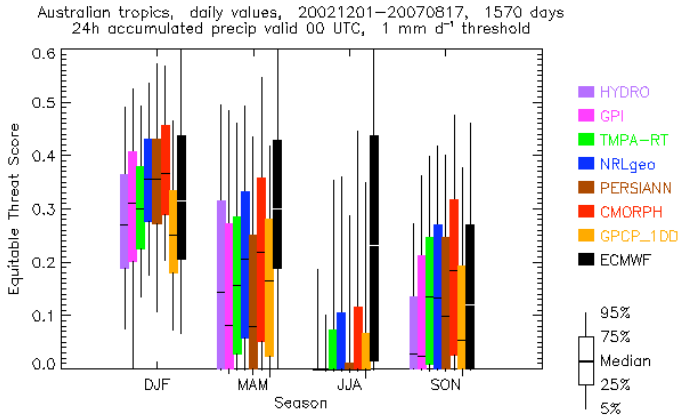
	3B40RT	3B41RT	TMPA-RT	CST
OBSERVED				
Rain Area (km^2 * 10^3)	1617.	1617.	1617.	1539.
Avg Intensity (mm/d)	10.82	10.82	10.82	11.03
Rain Volume (mm*km^2*10^6)	17.50	17.50	17.50	16.98
Max Intensity (mm/d)	85.82	85.82	85.82	85.82
ESTIMATED				
Rain Area (km^2 * 10^3)	1140.	1244.	1230.	1587.
Avg Intensity (mm/d)	15.95	14.15	14.78	10.11
Rain Volume (mm*km^2*10^6)	18.18	17.60	18.18	16.05
Max Intensity (mm/d)	185.09	98.94	156.48	61.90
# Gridpoints	9835	9835	9835	9189
Mean Abs Error (mm/d)	3.27	3.14	3.15	3.02
RMS Error (mm/d)	10.40	9.17	9.79	8.00
Avg. Correlation Coeff.	0.466	0.462	0.487	0.463
Bias Score	0.705	0.769	0.761	1.031
Probability of Detection	0.522	0.546	0.560	0.649
False Alarm Ratio	0.259	0.290	0.264	0.371
Critical Success Index	0.442	0.446	0.466	0.469
Hanssen & Kuipers Score	0.456	0.465	0.487	0.506
Equitable Threat Score	0.336	0.335	0.358	0.334







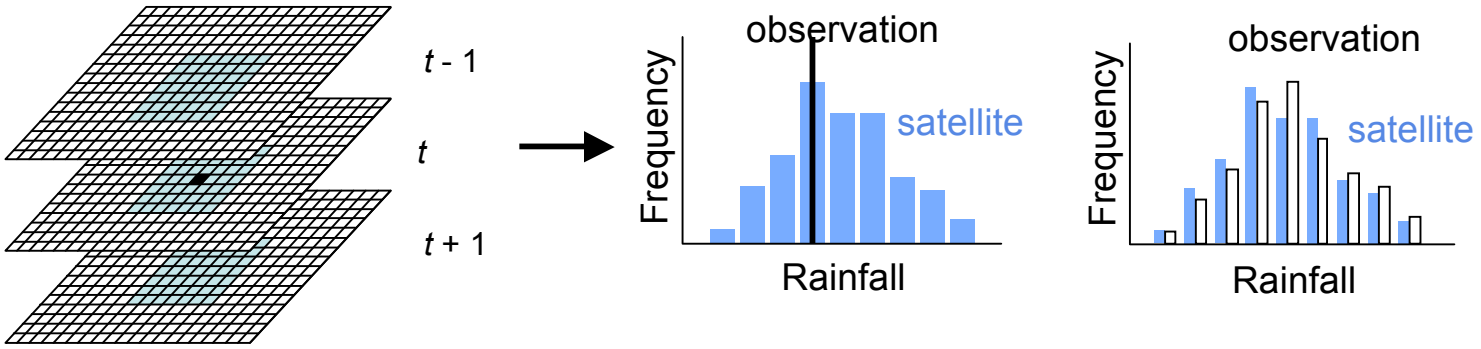




Multi-scale ("fuzzy") verification of high-resolution products

Q: Which scales can we trust? Which are useful?

Consider a space / time neighborhood around the point of interest



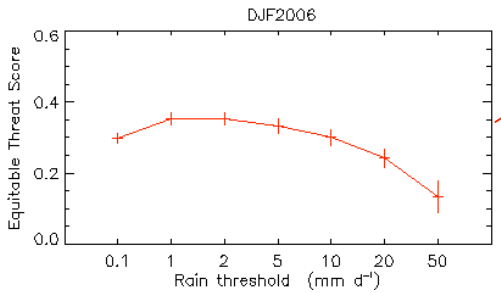
Treatment of satellite precipitation data within a window:

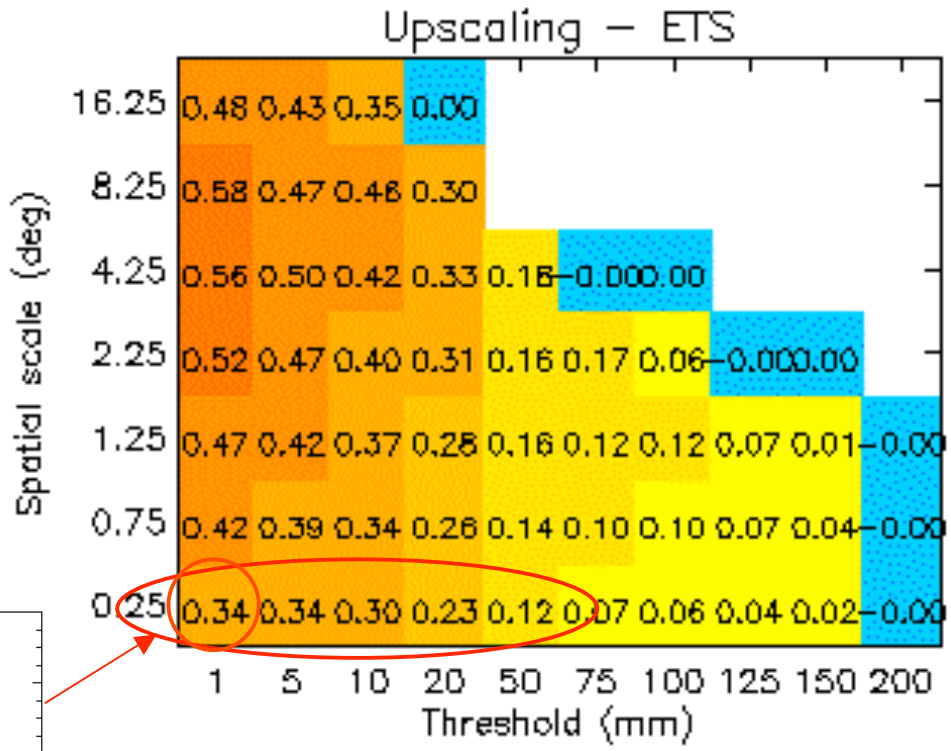
- Mean value (upscaling)
- Occurrence of rain event of certain magnitude somewhere in window
- Frequency of event in window → probability
- Distribution of values within window

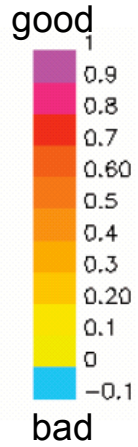
Evaluate using categorical, continuous, probabilistic scores

Multi-scale, multi-intensity approach

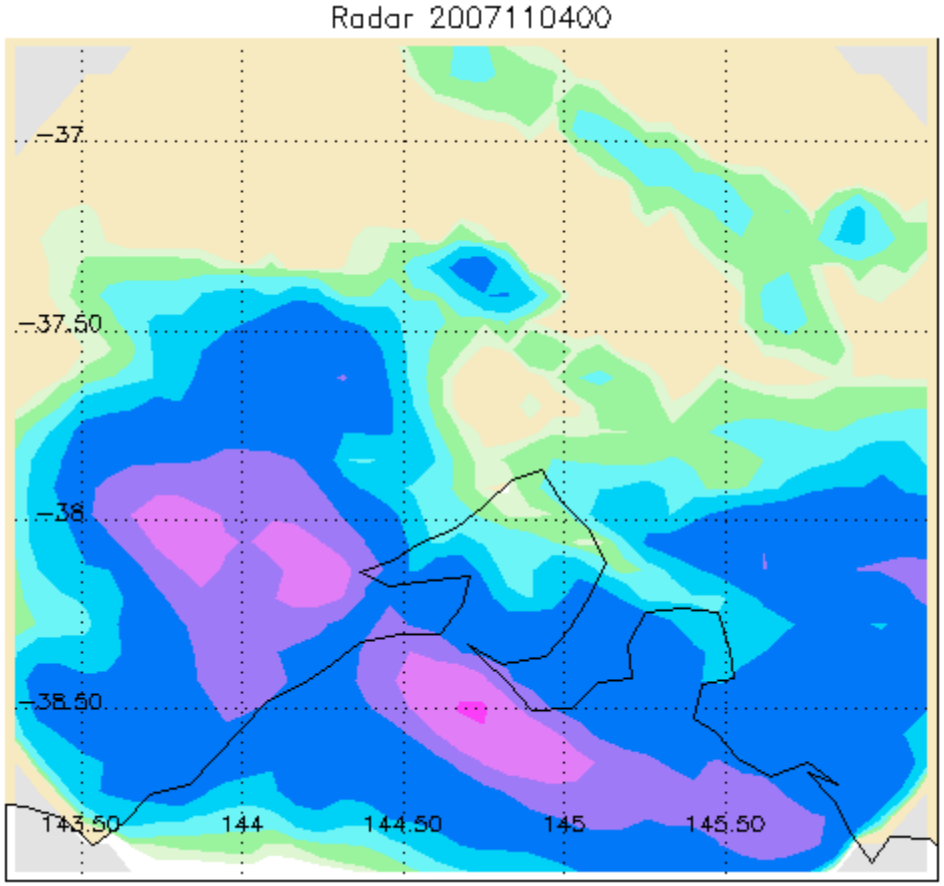
Performance depends on the scale and intensity

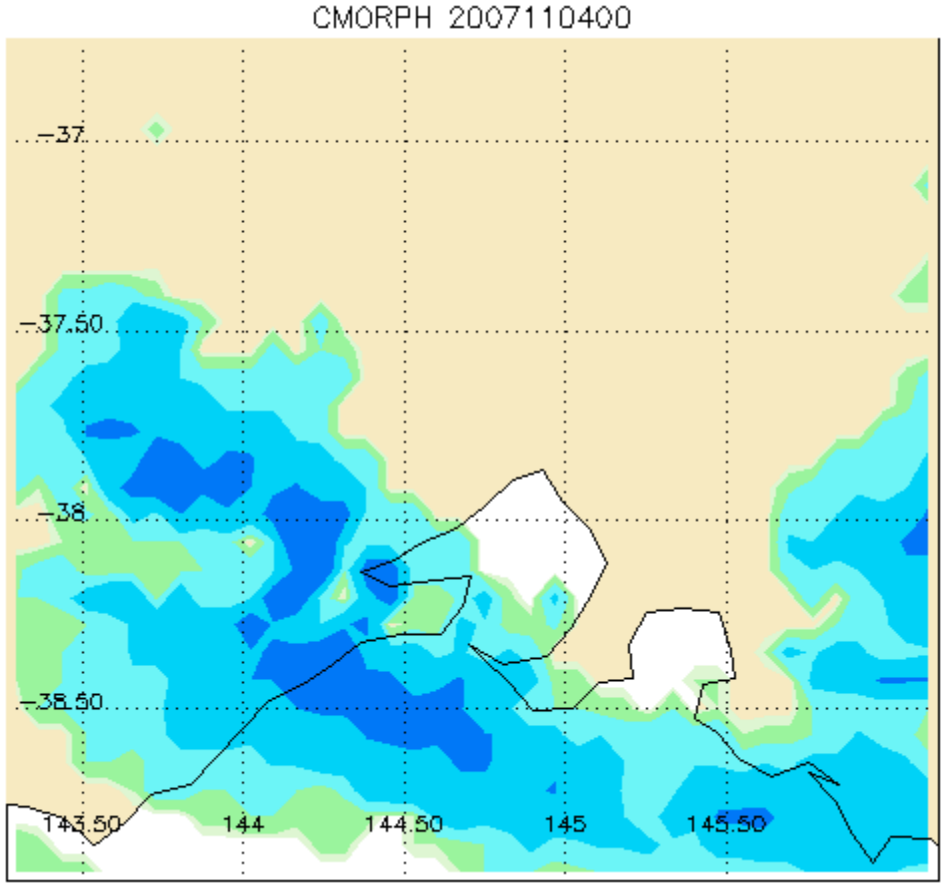


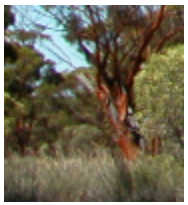




Very high resolution case – hourly 8 km CMORPH







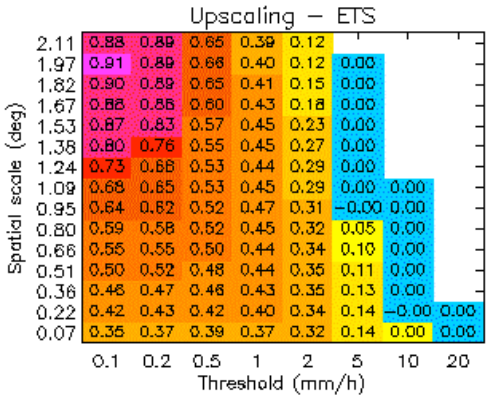
Melbourne heavy rain, 3 November 2007

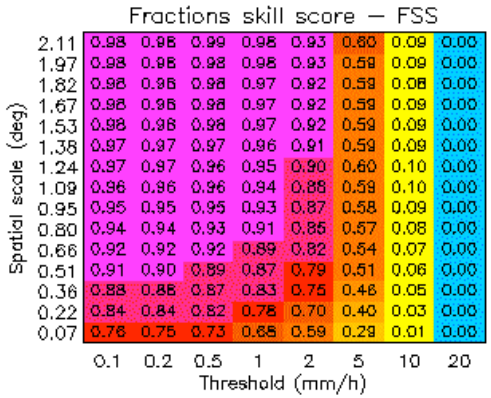
100 km

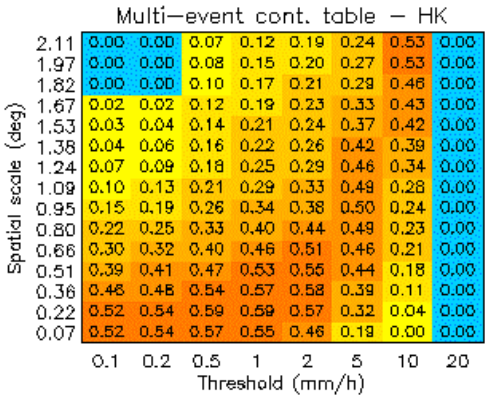
Very high resolution case – hourly 8 km CMORPH

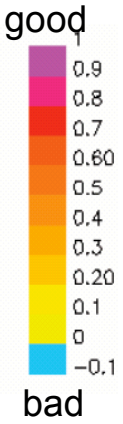
Fuzzy verification results for Melbourne aggregated for the 24 hrs on 3 Nov 2007

Δt = 0 (no temporal window)

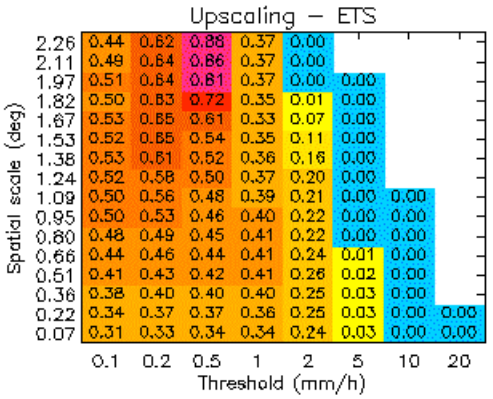


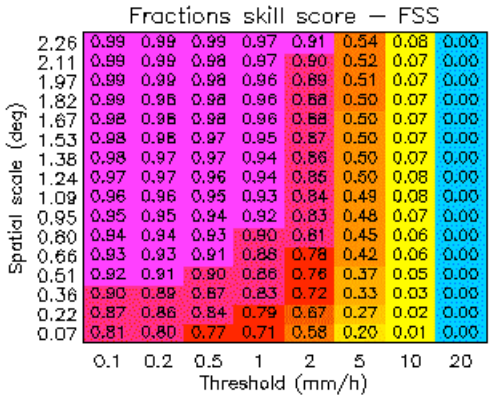


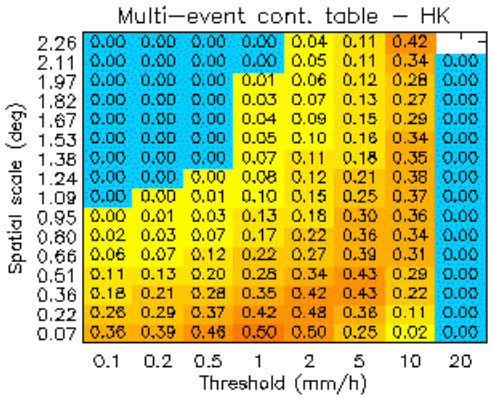


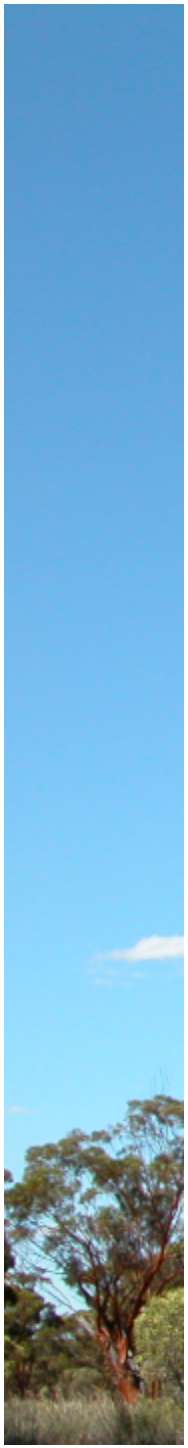


Δt = ±2 hrs









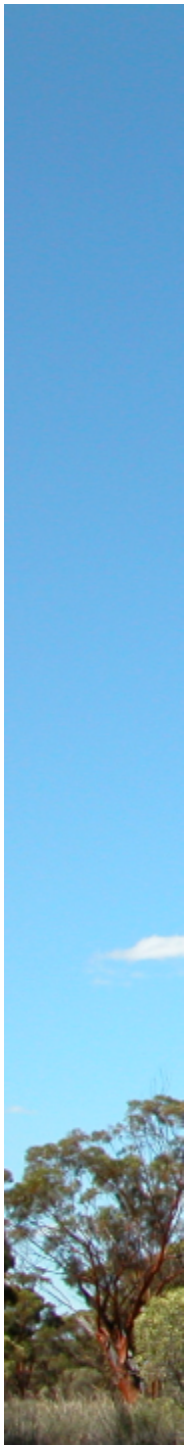
IPWG validation of satellite-based rainfall

Plans

- Continue regional daily rainfall validation
- Verify hourly and 3-hourly satellite precip estimates using multi-scale ("fuzzy") verification methods

Resources:

- Personnel:
  - Bureau of Meteorology – 1 part-time
  - Other partners – similar
- Computing / IT:
  - Satellite precipitation archive at CICS (U. Maryland)
  - IPWG validation web sites
    - Home page at Bureau of Meteorology
    - Regional validation web pages at participating centers
- Auxiliary data (BOM):
  - Operational daily rain gauge analysis
  - Rainfields hourly merged radar-gauge analysis



Validation Network comparison of satellite and surface radar data

Objectives and goals:

Pre-launch algorithm development:

- Compare reflectivity observations from PR / DPR and ground-based radar
- Evaluate ability of TRMM / GPM algorithms to diagnose spatial structure and intensity distribution of rainfall

Post-launch evaluation:

- Ongoing monitoring of DPR reflectivity and rainfall

Collaborating investigators:

NASA / GSFC

Bureau of Meteorology

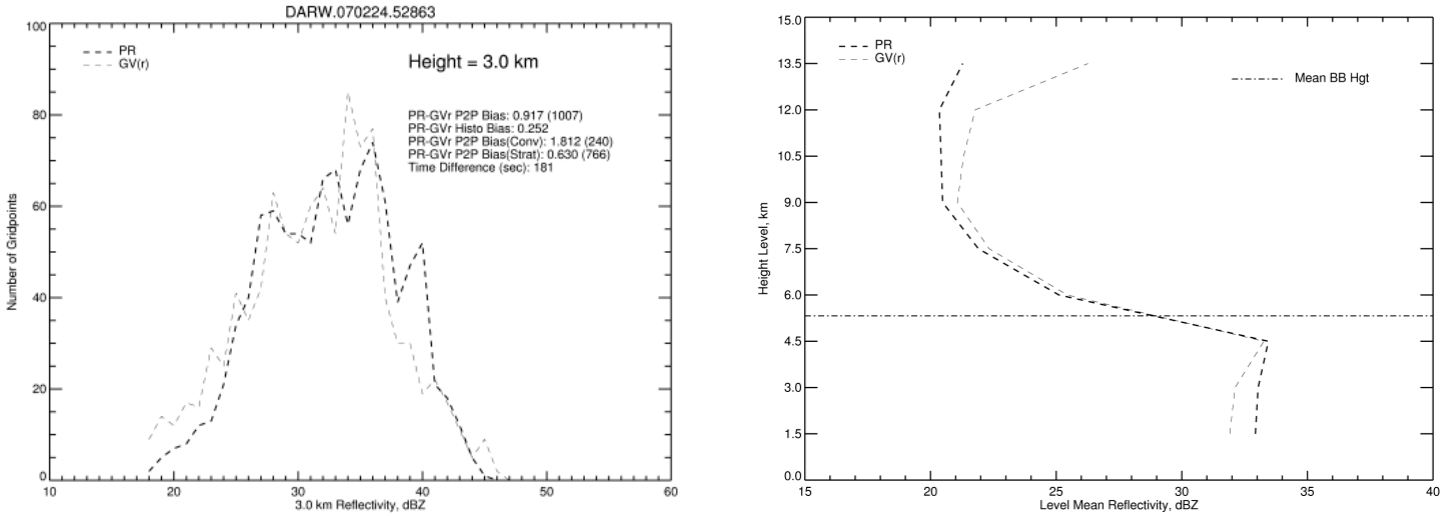
Others?

Validation Network – reflectivity comparison

Methodology and work plan:

Application of Validation Network software to 3D PR (DPR) match-ups with ground-based radar reflectivity and rainfall.

- Send Australian radar data to GSFC for processing, *or*
- Download satellite PR / DPR data for validation at BOM



TRMM PR and Darwin CPOL radar, 24 Feb 2007

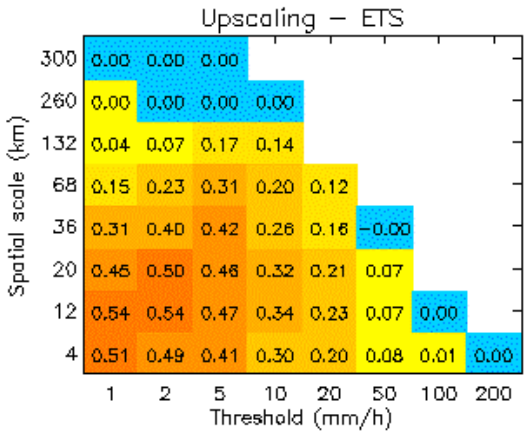
Courtesy Bob Morris

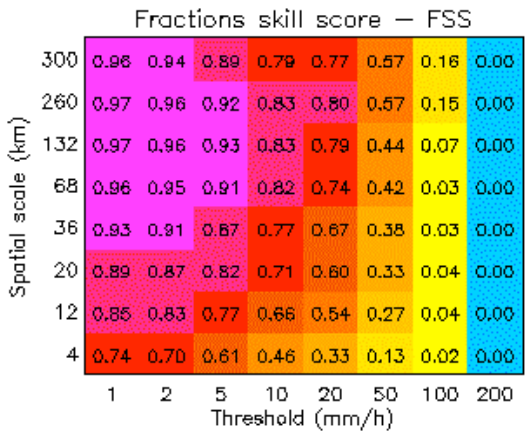
Validation Network – fuzzy verification

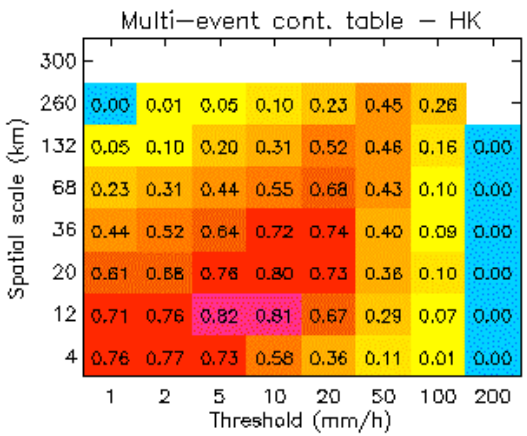
Methodology and work plan (cont'd):

Use multi-scale ("fuzzy") verification to investigate intensity- and scale-dependent performance of rainfall estimates

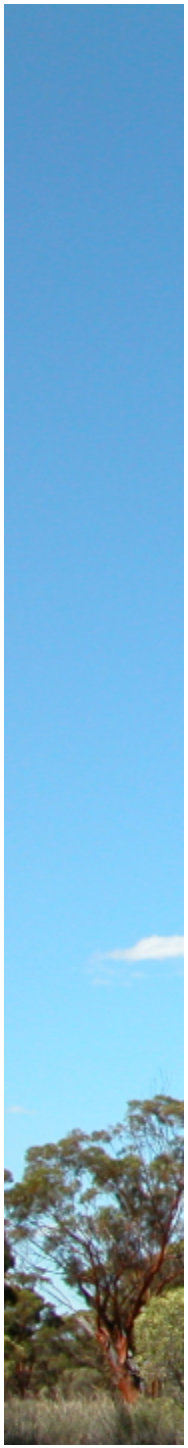
- Compare satellite-derived surface precipitation with merged radar-rain gauge analysis ("Rainfields") over Australia







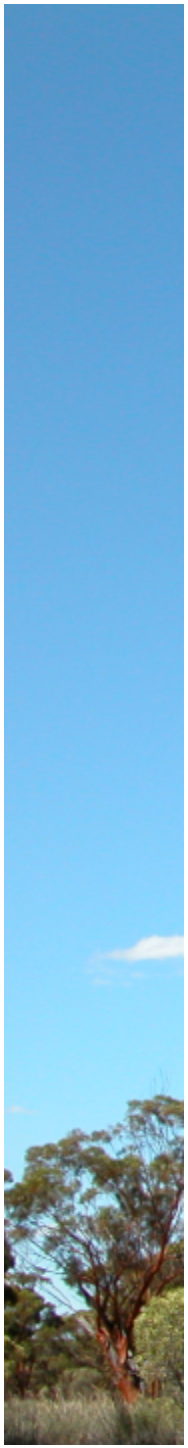
Results for Validation Network TRMM PR and NEXRAD radar in southeastern US, Aug 2006 - Aug 2007



Validation Network comparison of satellite and surface radar data

Resources:

- Personnel:
  - Bureau of Meteorology – 1 part-time, 1 post-doc?
- Computing / IT:
  - Validation Network web site
  - Archive at GSFC
- Auxiliary data (BOM):
  - Australian national radar network
  - Rainfields hourly merged radar-gauge analysis



Physical validation

Objectives and goals:

Pre-launch algorithm development:

- Investigate cloud and rain properties including microphysical characteristics using polarimetric radar and other instruments
  - Solid ground validation of D_0 and rain rate at the scale of the satellite footprint
- Collect cloud data that can be used to compare structural and microphysical properties from PR / DPR and polarimetric radar

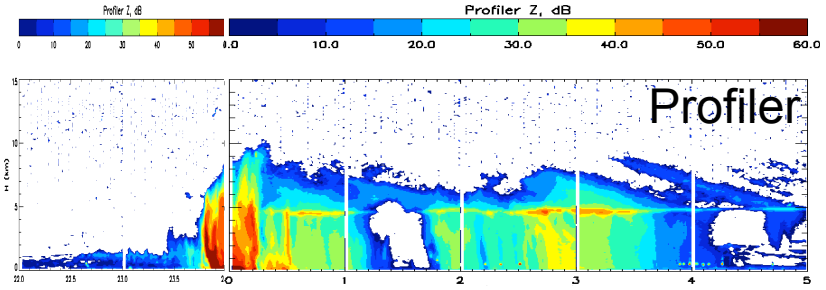
Post-launch evaluation:

- Ongoing comparison of cloud and rain properties derived from satellite and surface radar

Sites and instrumentation

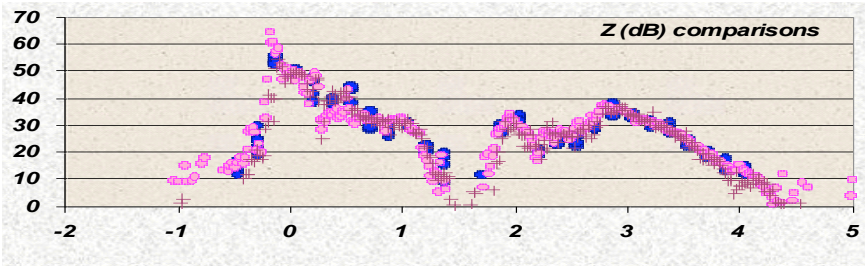
- Darwin Climate Monitoring Research Station
  - Polarimetric and Doppler radars, profiler, AWS, gauges, radiation, 35 GHz cloud radar, and other instruments
- ARM Tropical W. Pacific ARCS-3 Site at Darwin
  - Meteorological, radiation, cloud instruments
- CP-2 dual polarization dual wavelength radar in Brisbane
  - Dense rain gauge network

Reflectivity, D_0, and rain rate comparisons at Darwin



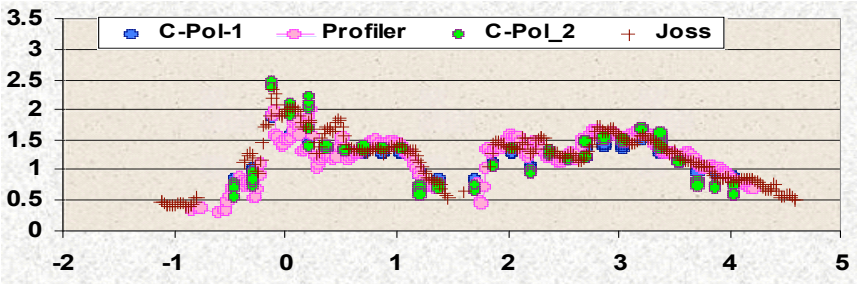
Jan 19-20 2006

reflectivity

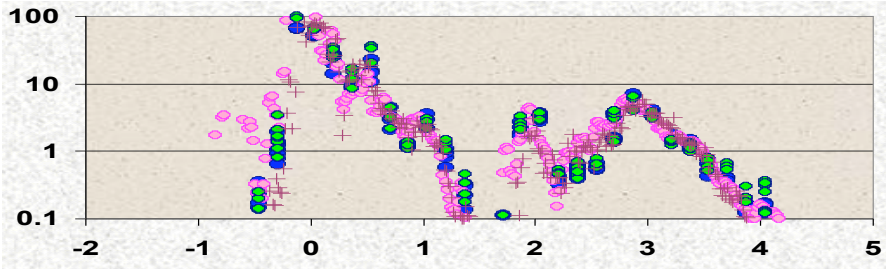


C-POL Z at 1.5 km
Profiler Z at 1.5 km
Joss Z at ground

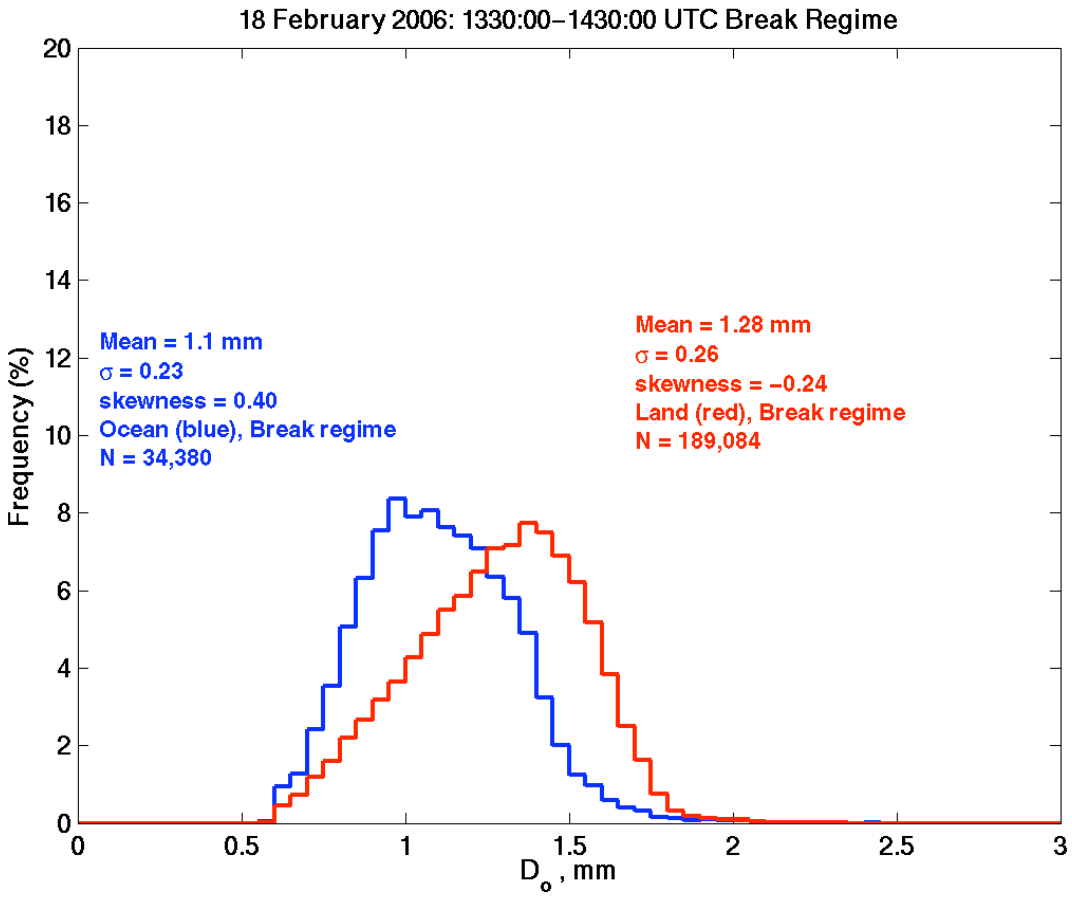
D_0 (mm)



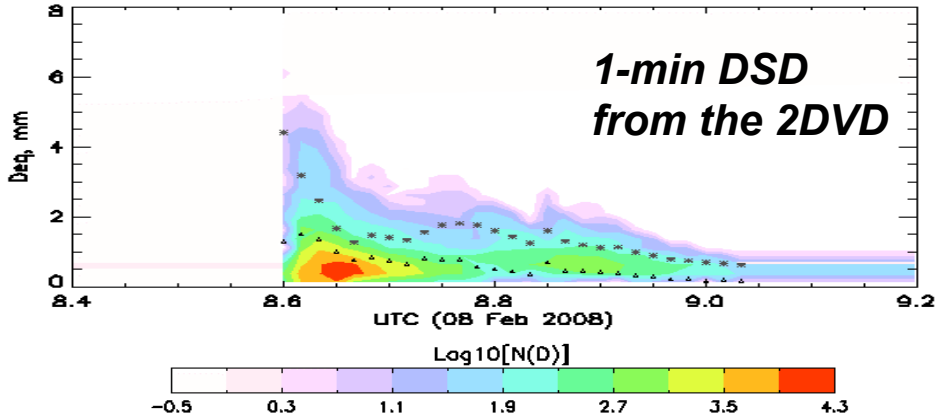
rain rate (mm/h)

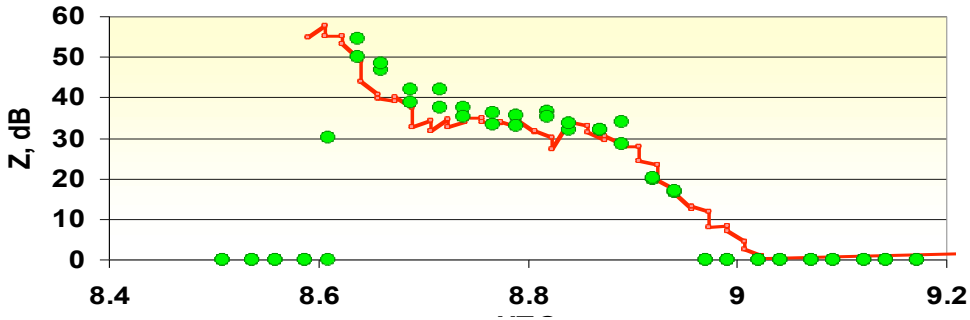


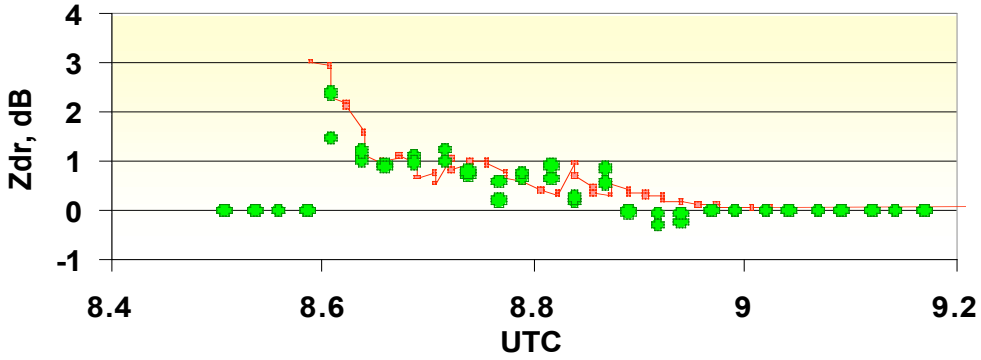
CPOL Histogram of D_o Land vs ocean (monsoon break regime)



CP-2 radar and 2DVD comparisons at Brisbane



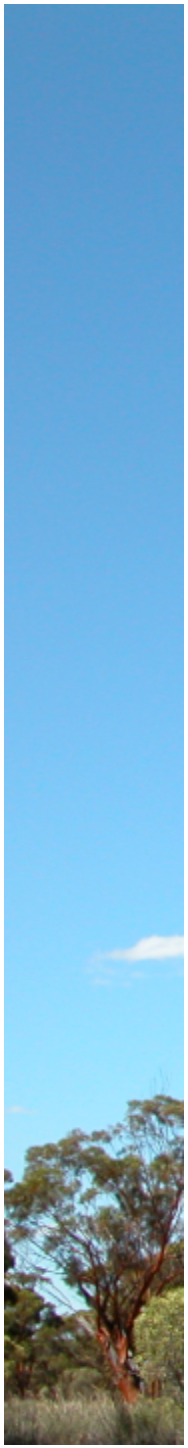




Time series comparisons (8 Feb 2008)

2DVD data based calculations

CP-2 radar measurements over the 2DVD



Physical validation

Collaborating investigators:

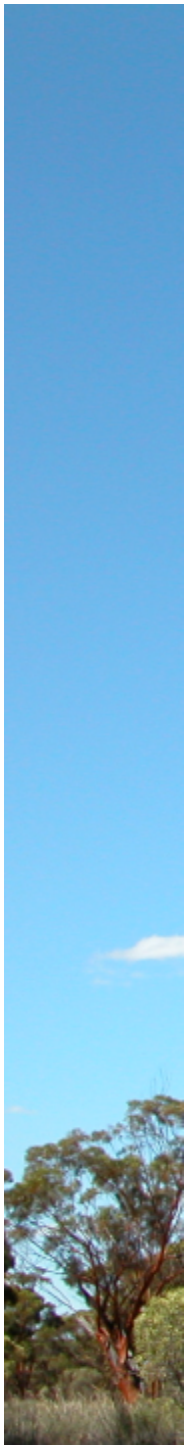
- Bureau of Meteorology
- Colorado State University
- University of Colorado

} doing comparisons with PR

- Manchester University
- University of Illinois
- ARM program

Resources:

- Personnel: 2 part-time, 2 post-docs
- Sites / Instrumentation: CPOL (Darwin) and CP-2 (Brisbane) polarimetric radars
  - Darwin Climate Monitoring Research Station
  - ARM site



Integrated hydrological validation

Objectives and goals:

Develop effective methods that combine data from multiple sources to issue streamflow forecasts

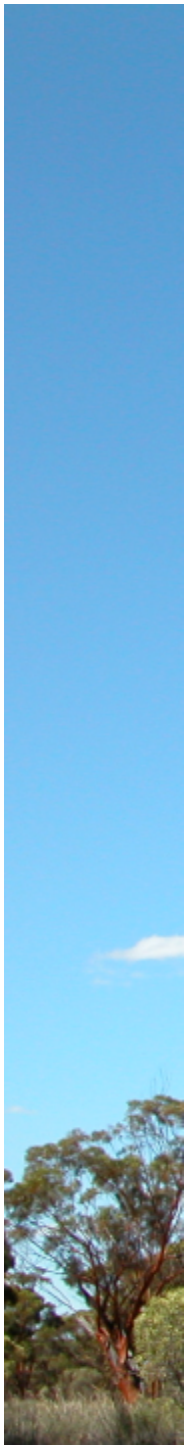
Post-launch evaluation:

- Assessment of utility of satellite-derived precipitation, used alone or in combination with other data, for driving streamflow predictions

Collaborating investigators:

Bureau of Meteorology

CSIRO



Integrated hydrological validation

Methodology and work plan:

Planning stages:

- Produce sub-daily high resolution national rainfall analyses combining data from satellite, radar, gauges
- Input precipitation analyses to hydrological models

Resources:

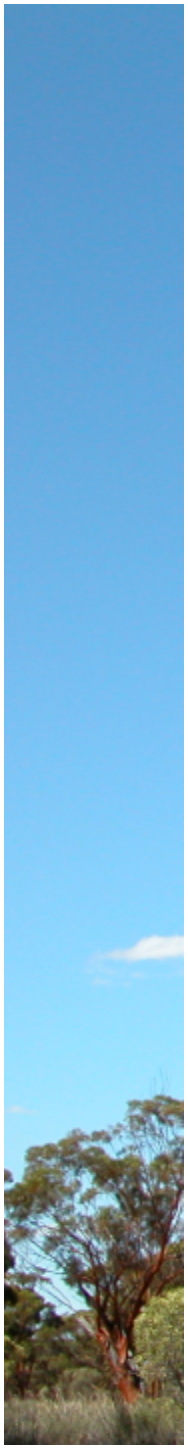
Personnel: 3 part-time?

Computing / IT: FTP & web site

National radar and rain gauge networks

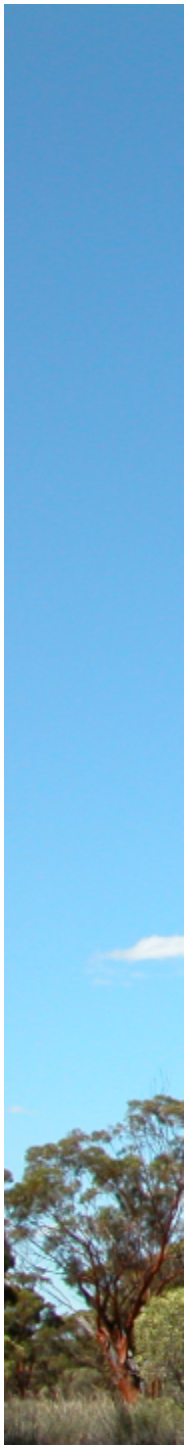
Rainfields hourly blended radar and rain gauge analyses

Stream gauge network



Synergies with others in GV community

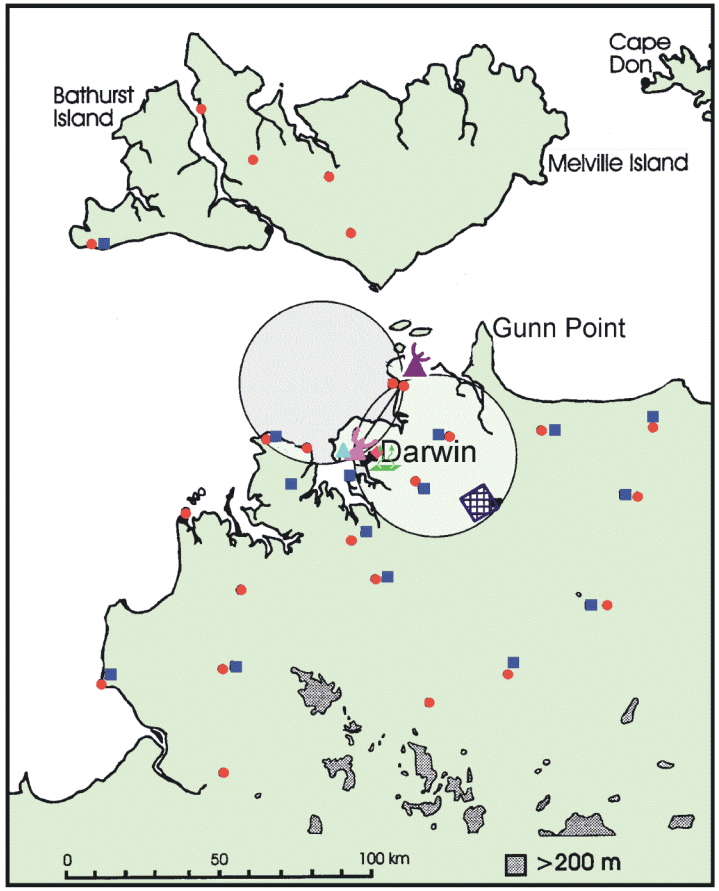
- Sharing of methodologies and software for
  - National network validation (IPWG)
  - Data handling (input, QC, regridding, etc.)
  - Multi-sensor rainfall analysis and blending
  - Objective verification of reflectivity profiles, rainfall estimates and streamflow predictions
- Standardized verification across regimes could contribute to development of global error model (F. Hossain)
- Sharing of cloud and rain observational data to aid in algorithm improvement

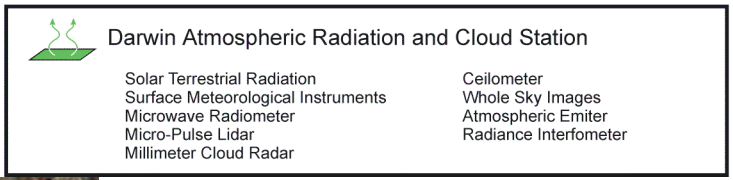


Summary and recommendations for collaboration

1. National network applications
   - Continue with IPWG regional validation activities, collaborating with data providers, algorithm developers, and validators
   - Expand GSFC Validation Network activities using match-ups of TRMM / GPM radar and Australian radar data
2. Physical validation
   - Provide high quality observational data for process studies to improve precipitation retrieval algorithms. More direct involvement in physical validation will require more resources
3. Integrated hydrological validation
   - We have little experience as yet – will be watching other groups to learn the most effective methodologies

Darwin Climate Monitoring Station





- Undertake climatological monitoring and research relevant to tropical convection in the monsoon environment of Darwin, Australia

  Emphasis on rainfall, vertical structure of hydrometeors, rainfall estimation

- Undertake detailed process studies relevant to defining the four dimensional structure, dynamics and microphysical properties of tropical convection

  Morphology and process studies

ARM Tropical Western Pacific ARCS-3 Site at Darwin

Cloud Properties

- Millimeter-Wavelength Cloud Radar (MMCR)
- Micropulse Lidar (MPL)
- Microwave Radiometer (MWR)
- Total Sky Imager (TSI)
- Vaisala Ceilometer (VCEIL)

Surface Meteorology

- Surface Meteorological Instruments for TWP (SMET)

Atmospheric Profiling

- Atmospheric Emitted Radiance Interferometer (AERI)
- Balloon-Borne Sounding System (SONDE)
- Microwave Radiometer (MWR)

Aerosols

- Cimel Sunphotometer (CSPHOT)

Longwave Spectral Radiation

- Atmospheric Emitted Radiance Interferometer (AERI)

Shortwave Spectral Radiation

- Cimel Sunphotometer (CSPHOT)
- Multifilter Rotating Shadowband Radiometer (MFRSR)

Shortwave and Longwave Broadband Radiation

- Ground Radiometers on Stand for Upwelling Radiation (GNDRAD)
- Sky Radiometers on Stand for Downwelling Radiation (SKYRAD)